Observations on the Pollination Ecology of *Eucalyptus muellerana* Howitt in East Gippsland

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Introduction

The flowers of *Eucalyptus* are visited by a wide range of insects, birds and mammals (Griffin, 1982) and this observation has led to various conclusions that the genus is pollinated by vectors most of which are insects (Pryor, 1976), predominantly ornithophilous (Faegri & van der Pijl, 1979), or pollinated by a wide variety of vectors ". . . first by birds, later in the day by insects such as bees, flies and beetles and at night by mammals and possibly moths" (Ford *et al.,* 1979).

Eucalypt pollen has certainly been shown to be an important food source for lorikeets (Churchill & Christensen, 1970) and the feather-tailed glider (Turner, 1984); some honey-eaters rely on eucalypt nectar (Ford & Paton, 1977; Ford *et al.,* 1979) and this is also true of the honey possum (Hopper & Burbridge, 1982); while all insects observed feeding on the flowers may be assumed to be consuming a major component of their diet. However, it is not valid to infer from such observations that the respective animals are necessarily fulfilling a pollination function.

Effective pollination requires that visits occur at a time when stigmas are receptive; that feeding is non-destructive and involves regular stigma contact; that body structure is such that pollen is carried on those parts of the body which make stigma contact; that inter-tree movements are frequent and that population sizes are such that significant quantities of pollen are transferred. Only when such information is available for the complete array of flower-visiting animals can the effective pollinators of a particular species be determined.

The most distinctive feature of the eucalypt flower bud is the operculum, which is shed at anthesis. The open flower thus has no perianth, but visitors are attracted by numerous showy stamens. Nectaries, situated on top of the receptacle around the base of the style, secrete copious nectar. While all species have this generalised flower structure (Pryor, 1976), they do vary substantially in a number of traits such as flowering time, blossom structure and flower size, colour, presentation and degree of nectar exposure (Griffin, 1982).

There are corresponding differences in effective vectors. For example *E. stoatei* has large flowers with filaments tightly incurved around the style and nectar is only accessible to honey-eaters (Hopper & Moran, 1981) while the more open dish-shaped flowers of *E. foecunda* Schau and *E. cylindriflora* Maid. & Blakely are considered to be pollinated by beetles (Hawkeswood, 1982). It is obviously not possible to generalise regarding eucalypt pollinators until a far greater body of observational data has been collected.

This paper reports a preliminary investigation of the pollinators of *E. muellerana* Howitt, a summer-flowering stringybark species which grows in the coastal ranges of eastern Victoria and southern New South Wales.

Methods

Observations were made between 14 October 1983 and 13 January 1984 on a group of five trees of *E. muellerana* growing in a natural stand in the Clifton Creek area, north of Bairnsdale, Victoria. The trees were in a mixed stand with *E.*

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globulus Labill. subsp. *maidenii* (F. Muell.) Kirkp.; *E. sideroxylon* A. Cunn. ex Woolls subsp. *tricarpa* L. Johnson, *E. polyanthemos* Schau; and occasional *E. bridgesiana* R. T. Bak. None of these species was flowering at the same time as *E. muellerana.*

The study period covered the complete flowering season. Trees were selected according to the accessibility of flowers to the observer, so observations relate to visitor activity on the lower branches only.

Observations were made on 19 separate days. Since animal activity was low on wet and windy days, such conditions were avoided. Casual observation also revealed little aetivity at night or early in the morning, and thus detailed observations were carried out only in daylight hours.

The blossom of *E. muellerana* consists of axillary infloreseenees each containing up to 12 flowers (Hall *et al.,* 1970) with creamy-white filaments as the most obvious secondary attractant. At full development the inflorescence appears spherical with a diameter of about 30mm.

Floral development was studied *in vivo* on four marked flowers. Nectar secretion was measured on flowers enclosed in a terylene bag, over a 24-hour period from noon to noon. Every three hours a sample of three flowers was removed and nectar extraeted from each with a 5 µl capillary tube. Flower visitors were recorded during 44 half-hour observation periods on observation units of 10-15 inflorescences, and insects were captured by hand at other times.

Feeding behaviour of eaeh of the major visitor taxa was observed in order to assess potential for effecting pollination.

Results and Discussion

Floral Development

The course of development of the flower from operculum shed (day 0) follows that described for other eucalypt species (Pryor, 1976; Griffin & Hand, 1979). The flower is protandrous with filaments fully expanded and anthers dehisced by about day 2. Since the filaments become reflexed in this species the nectar secreted from the surface of the receptacle is easily accessible to visitors.

Even though pollen is shed, filaments persist for 12-14 days and thus continue to provide a visual attractant.

The style is about 3mm long at day 0 and doubles in length by day 4 when the stigma begins to expand and becomes receptive. The style abscisses after about 24 days.

Small quantities of nectar were collected from bagged flowers within 24 hours of operculum-shed and peak daily production of 5 µl per flower was reached by day 3. The major production period was overnight so maximum quantities of nectar were present during early daylight hours. The development pattern was somewhat faster than that reported for the autumn-flowering species *E. regnans* (Griffin & Hand, 1979) — a difference most probably due to ambient weather conditions.

Insect Visitors

Insects captured on flowers represented four orders, with 41 species from 29 families (Table 1). However as can be seen from Table 2 only a few taxa were frequent in any one observation period.

Effective Vectors

The significant visitors to flowers of *E. muellerana* varied during the course of the flowering season (Table 2). Stigma contact during feeding was used as an indication of vector status, and only *bona fide* vectors are included on the table.

Dipteran species *(Helina* sp. *and Syrphus damastar)* and wasps (Tiphiidae sp.) were dominant early in the flowering season. Hymenoptera, chiefly the bee *Homalictus,* of which two species were identified, were the most common visitors during the middle of the season, while at

the end of the flowering season beetles, chiefly *Mordella* sp. and *Eleale* sp. were by far the most frequent visitors.

Robbers

Several small (<3mm) dipteran species appeared to be feeding on nectar without contacting the stigma. Detailed observations of a single inflorescence for two half-hour periods showed that during 35 visits of these insects (Ephyridae, Empididae, *Sciara* sp.) no stigma contact occurred. It is possible that the hoverfly, *Syrphus damaster,* should also be placed in this category as it has a smooth body and no pollen could be seen on specimens inspected with a hand lens in the field, but because of their large size and frequent stigma contact they will be considered as vectors until more information is available.

Table 1 **Insect visitors captured on flowers of *E. muellerana* throughout the flowering season.**

Diptera

Helina — 3 spp.
Rivellia
Sciaridae — 4 spp.
Empididae
Heleomyzidae
Syrphidae *(Syrphus damastar)*
Ephydridae
Muscidae — 2 spp. *(Fannia* sp. and *Musca* sp.)
Calliphoridae *(Calliphora* sp.)

Hymenoptera

Halictidae *(Homalictus punctatus* and *Homalictus dixonii)*
Tiphiidae *(Anthobosca* sp.)
Formicidae *(Camponotus* sp., *Heteroponera* sp.)
Pompilidae *(Episyron* sp.)
Pergidae *(Lophyrotoma* sp., *Cyanea* sp.)
Colletidae *(Euryglossa ephippiata, Leioproctus* (2 spp.), *Hylaeus* sp.)
Apidae *(Apis mellifera)*

Coleoptera

Curculionidae
Carabidae
Dermestidae — 2 spp.
Heteromastix sp.
Oroderes sp.
Mordellidae *(Mordella* sp.)
Cleridae — 2 spp.
Scarabaeidae — *(Phyllotocus* sp.)

Lepidoptera

Lycaenidae *(Jalmenus* sp.)
Amatidae *(Syntomis* sp.)
Nymphalidae

Bird Activity

Four species of bird were observed near the flowers in October. Two were honeyeaters (yellow-faced honeyeaters, *Meliphaga chrysops,* and red wattle bird, *Anthochaera carunculata)* and two were insectivores (scarlet robin, *Petroica multicolor* and yellow-tailed thornbill *Acanthiza chrysorrhoa).* All were feeding on insects around the flowers, not on nectar. While crashing into the flowers in their pursuit they probably effected some incidental pollination, but the visits of these birds were too few and sporadic to consider them as regular vectors.

Meliphaga chrysops and *Anthochaera carunculata* have both been recorded as nectar feeders on other species of *Eucalyptus* (Ford & Paton, 1977).

Later in the season no birds were observed at all in the flowering trees, despite the presence of a pair of yellow-faced honeyeaters noted attending a nest in shrubs only a few metres away.

Conclusion

The observations made during this season showed that flowers of *E. muellerana* were visited by a wide range of insects, but that the flowers did not appear to be a major food source for birds.

Because sample sizes were small and observations periods irregular it would be premature to draw firm conclusions about the relative importance of the different

Table 2: Insect pollen vectors observed visiting groups of 10-15 flowers of *E. muellerana* over the flowering period October 1983-January 1984.

Period of Observation	14.10.83-20.10.83	28.11.83-7.12.83	11.12.83-18.12.83	29.12.83-13.1.84
Duration of Observation (Hr)	8	5	3	6
Diptera				
Hoverfly *Syrphus damaster*	18	38	—	—
Bushfly *Helina* sp.	34	20	4	6
Blowfly *Calliphora sp.*	5	56	14	7
Other Diptera	6	3	—	3
Hymenoptera				
Tiphiidae sp.	16	—	1	2
Homalictus sp.	4	110	56	—
Colletidae sp.	—	6	6	18
Honeybee *Apis mellifera*	—	—	4	—
Formicidae	10	2	5	3
Other Hymenoptera	6	3	—	3
Coleoptera				
Pin-tailed beetles *Mordella* sp.	—	—	8	98
Eleale sp.	—	—	20	45
Weevil Curculionidae sp.	2	—	—	—
Other Coleoptera	7	—	—	16
Lepidoptera				
Nymphalidae	—	—	4	10
Lycaenidae	—	—	5	15

visitors as pollinators of this species. Nevertheless the study demonstrated that visiting insects *could* be categorised as: 1) nectar thieves which made no stigma contact; 2) taxa which may effect pollination but which are present in low number and hence do not make a major contribution to pollen transfer; 3) and those which were both effective and of high population density. Furthermore the identity of effective pollinators may vary significantly over time, and we should consider *E. muellerana* as being pollinated by a suite of native bees, flies and beetles.

Potential for pollination by a variety of different insects may well be of considerable adaptive advantage where climate is erratic and flowering not very predictable, as pointed out by Ford *et al.* (1979).

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REFERENCES

Churchill, D. M. and Christensen, P. (1970). Obser-

vations on pollen harvesting by brush tongued lorikeets. *Aust. J. Zool.* 18: 427-37.
Faegri, K. and Van der Pijl, L. (1979). *Principles of Pollination Ecology.* Pergamon Press, Oxford.
Ford, H. A. and Paton, D. C. (1977). The comparative ecology of ten species of honeyeaters in South Australia. *Aust. J. Ecol.* 2: 399-407.
Ford, H. A., Paton, D. C. and Forde, N. (1979). Birds as pollinators of Australian plants. *N.Z. J. Bot.* 17: 509-19.
Griffin, A. R. (1982). Pollination ecology of *Eucalyptus* — a framework for study. Proc. of Symposium 'Pollination '82, Univ. of Melbourne. Eds: Williams, E. G., Knox, R. B., Gilbert, J. H. and Bernhardt, P.
Griffin, A. R. and Hand, F. C. (1979). Post-anthesis development of flowers of *Eucalyptus regnans* and the timing of controlled pollination. *Aust. For. Res.* 9: 9-15.
Hall, N., Johnson, R. D. and Chippendale G. M. (1970). *Forest Trees of Australia.* Aust. Govt. Publ. Serv. Canberra.
Hawkeswood, T. J. (1982). Notes on insect pollination of two species of *Eucalyptus* from south-west Western Australia. *Victorian Nat.* 99: 28-37.
Hopper, S. D. and Burbridge, A. A. (1982). Feeding behaviour of birds and mammals on flowers of *Banksia grandis* and *Eucalyptus angulosa* in *Pollination and Evolution.* Eds: Armstrong, J. A., Powell, J. M. and Richards, A. J. Royal Botanic Gardens, Sydney.
Hopper, S. D. and Moran, G. F. (1981). Bird pollination and the mating system of *Eucalyptus stoatei. Aust. J. Bot.* 29: 625-38.
Pryor, L. D. (1976). *The Biology of Eucalyptus.* Edward Arnold, London.
Turner, V. (1984). *Eucalyptus* pollen in the diet of the feathertailed glider. *Aust. Wildlife Res.* 11: 71-81.

Naturalist Reviews

A number of useful Australian field guides have been recently published which are cheap (under $20), locally relevant and probably most importantly, are accurate.

"A Guide to the Freshwater Fish of Victoria" by Philip Cadwallader and Gary Backhouse ($13.50; Victorian Government Printer) is a handy guide to our State's freshwater fish written by two officers from the Fisheries and Wildlife Division. A small but wide ranging introduction covers Victoria's inland waters, the impact that humans have had on native fish, collecting and photographing fish, fish parasites and the structure and classification of fish. The guide then gives details of each known freshwater Victorian species — a full description (including common and scientific names), a distribution map and notes on behaviour, food, breeding and value to man. With an easy to use key to the relevant families (complete with glossary), a reference list, index and 58 colour photographs, the book will prove highly useful to naturalist, field biologists and anglers.

The South Australian Government Printer has recently published two handbooks to marine fauna and flora *("Marine Invertebrates of Southern Australia. Pt 1"* ed. by S. Shepherd and I. Thomas and *"The Marine Benthic Flora of Southern Australia"* by H. Womersley). These constitute two publications in the continuing series of handbooks on the flora and fauna of South Australia which can be obtained from the State Information Centre, Grenfell Centre Plaza, 25 Grenfell Street, Adelaide, S.A. 5000.

Both books have introductory chapters on the ecology of the environments studied. The fauna handbook has information on the marine environment and food webs (listing the types of feeding used by invertebrates in their different habitats); the flora guide on the other hand, has chapters on local distribution of marine flora, collecting and preserving marine plants, the history of studies of southern Australian marine algae, and the ecology and biogeography of marine plants in this region. The major parts of these books deal with descriptions of the species (in some cases higher taxons) of animals and plants found around coastal, southern Australia. Excellent keys are provided, although non-biologists will certainly have to refer to the extensive glossaries when using them. Each of the handbooks is accompanied by com-